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CONCEPTUAL DESIGN SUMMARY
GROUNDWATER ICM MODIFICATION

GLENN SPRINGS HOLDINGS, INC.
OCCIDENTAL CHEMICAL CORPORATION FACILITY
WICHITA, KANSAS

Revision 2 (August 26, 2011)

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1.0 INTRODUCTION

The Occidental Chemical Corporation (OCC) Wichita Facility (Site or Facility) is located at 6200 S. Ridge Road, Wichita, Sedgwick County, Kansas (Figure 1). The Site is a chemical manufacturing plant which produces chlorine, caustic, hydrogen, sodium chlorite, hydrochloric acid, methylene chloride, methyl chloride, chloroform, and carbon tetrachloride.

Investigation of environmental conditions beginning in the 1960s identified groundwater impacts associated with the products manufactured at the Facility. Hydraulic management of the groundwater to control these impacts began in the late 1960s.

The 2007 Resource Conservation and Recovery Act (RCRA) Operating Permit section on Stabilization and Interim Measures requires OCC to "continue to operate and maintain the groundwater management system in existence as of the date of this permit" (2007 RCRA Permit, Part II, p. 22). The groundwater management system includes a network of interceptor wells to contain and capture impacted groundwater.

This report presents a summary of the conceptual design for a modification to the Interim Corrective Measure (ICM) for containing and capturing impacted groundwater at the Site. The objective of this report is to present the conceptual design details for the proposed modification. Further details are provided by the following.

2.0 SITE GEOLOGY AND HYDROGEOLOGY

The Site geology and hydrogeology has been established based on data garnered over more than thirty years of investigative and corrective action history. The geology and hydrogeology are summarized below. The locations of monitoring and interceptor wells relative to the Site are provided on Figure 2.

2.1 SITE GEOLOGY

There are four generally discrete sand units, S1 through S4 (oldest to youngest), separated by a sequence of clays and silts, C1 through C4 (oldest to youngest), unconformably deposited and overlying the Wellington Formation. Recent investigative work has shown that to the east and northeast of the OCC Facility, the clay/silt units separating the sands begin to lose continuity, and the S1 aquifer pinches out where the Wellington bedrock surface rises to within 50 to 60 feet below ground surface. Moreover, regional geologic information indicates that the S1 sand unit also pinches out approximately 1 mile to the west and to the south.

As the geologic cross-sections illustrate (as summarized within the Interceptor Well Interim Corrective Measures Effectiveness Evaluation (CRA February 2010)), the uppermost sand unit (S4) is separated from the lower sand units by the C3 clay. During the Inorganics Area investigation (CRA February 2011), the presence of the C3 clay layer was confirmed in 49 of the 52 soil borings completed to a depth of greater than 32 feet. Seven borings were advanced to a total depth of less than 32 feet. In three pilot borings advanced through the C3 clay layer, the thickness of the C3 unit ranged from 11 to 14.5 feet in thickness. Perched water was observed in six investigative borings. However, the perched water appeared intermittently and was not reflective of a continuous water-bearing unit.

Previous geologic interpretations indicated that the S3 and S2 sand units were generally isolated by a clay layer (C2 unit) and that groundwater in the thin S2 zone occurred under confined conditions. This assessment appears to be true but in only very limited areas because the C2 clay unit is not continuous and is thin or absent in some areas. Moreover, drilling logs and potentiometric surface data strongly indicate that the S2 and S3 aquifer units are in hydraulic connection and respond in a similar fashion to pumping stresses produced by the interceptor well (IW) system at the Facility.

The lowermost sand unit (S1) overlies the shale bedrock and appears to be isolated from the upper sand units by a continuous C1 clay/silt layer. As previously noted, the S1 sand unit pinches out to the east and west where the Wellington bedrock surface rises to within 50 to 60 feet below ground surface.

2.2 SITE HYDROGEOLOGY

Based on the conceptual geologic model, a hydrogeologic model has been developed. Specifically, groundwater beneath the Facility occurs in unconfined, semi-confined, and confined sand units separated by low permeability clay or silty clay layers. The hydrogeologic model was evaluated in the Interceptor Well System Interim Corrective Measures Effectiveness Evaluation (CRA February 2010) and the major conclusions concerning the hydrogeologic units are included in the summary provided below.

2.2.1 OVERBURDEN AQUIFERS

The S1 (deep) and S2/S3 (shallow) aquifer units are the primary regional water bearing units at the Facility. Static water levels in the plant area in S1 and S2/S3 monitoring wells are generally at or about 1,260 feet mean sea level, or 45 to 50 feet below grade. Regional groundwater flow, when the systems are not stressed, is believed to be to the south-southeast in both the S1 and S2/S3 saturated zones.

Groundwater elevations in nested wells screened in the S2 and S3 sand units are similar across the Site and indicate that the S2 and S3 act as a single interconnected combined S2/S3 aquifer. The similarity between the S2 and S3 water table on geologic cross-sections further confirms the conclusion that the S2 and S3 aquifer units are in hydraulic connection and respond in similar fashion to pumping stresses produced by the IW system at the Facility. The hydrogeologic model is supported by boring log information, hydraulic monitoring data and the current conceptual model of the subsurface stratigraphy beneath the Facility and the surrounding area, as summarized in the Interceptor Well System Interim Corrective Measure Effectiveness Evaluation (CRA February 2010). The similarity between the S2 and S3 groundwater elevations have been observed during the semiannual groundwater monitoring events, and the S2 and S3 units are contoured as one combined aquifer.

The key components of the current conceptual hydrogeologic model are:

- The S2 and S3 aquifer units are in hydraulic connection and are one S2/S3 hydrostratigraphic unit.
- Regional groundwater flow is generally to the south-southeast in both the S1 and S2/S3 aquifers.
- The S1 sand unit is confined; isolated from the upper sand units by the C1 clay/silt layer.
- The S1 sand unit pinches out to the east and west of the Facility where the Wellington bedrock surface rises to within 50 to 60 feet below ground surface.
- The bedrock has low hydraulic conductivity and has not been impacted by the Site.

3.0 INTERCEPTOR WELLS (IW43 AND IW44)

3.1 SUPPLEMENTAL INTERCEPTOR WELL OVERVIEW

In 2010, two new monitoring wells, MW140S2/S3 and MW140S1, were installed approximately one half mile southeast of the OCC Facility (Figure 2). Monitoring well MW140S1 was free of Site-related compounds. However, MW140S2/S3 did contain Site-related compounds; therefore, the two new Interceptor Wells, IW43 and IW44, have been installed southeast of the OCC facility in the S2/S3 aquifer (Figure 3).

A preliminary hydraulic evaluation indicates that pumping at a rate of 50 gpm from each of the two new interceptor wells and 50 gpm from the existing interceptor well, IW40, will capture groundwater in the area of MW140S2/S3. The preliminary hydraulic evaluation was a 2-dimensional analytic element modeling effort using GFLOW2000. GFLOW is a commercial version of the USEPA's Wellhead Analytic Element Model (WhAEM2000). As applied, the model is relatively simple and used assumptions similar to those used to estimate capture zones in the 2010 Interceptor Well Interim Corrective Measures Effectiveness Evaluation Report. The GFLOW model assumes a uniform southeasterly hydraulic gradient, a homogeneous infinite aquifer with constant transmissivity and fully-penetrating wells. While relatively simple, the analytic element model provides a quantitative tool to accurately calculate well capture zones and realistically simulates the interaction between multiple pumping wells. The model allows rapid assessment of different well configurations (well placement and pumping rates). The capability to accurately simulate capture zones from multiple wells is an important basis for the USEPA publishing WhAEM.

The design shown in Figure 4 (modeled capture zones overlain on a carbon tetrachloride plume interpolated using Golden Surfer and 2010 groundwater data) was considered an effective approach. The simulation has the two new interceptor wells pumping 50 gpm each. The engineering design for the conveyance and future treatment system has the wells and piping sized to handle up to 100 gpm each from the new wells, providing a factor of safety of two if 50 gpm each is insufficient. New monitoring wells have been installed to assess the hydraulic performance and to support optimization of the recovery system.

Initially, recovered groundwater from IW40, IW43 and IW44 will discharge via underground piping to the existing forcemain from IW40 to the OCC facility, and will be discharged via the currently permitted deep well injection system. The new extraction wells will operate continuously until flow is optimized (based on further hydraulic monitoring in the area of MW140S2/S3).

Permits for the new system included Water Use Permits for the new interceptor wells. To that end, Water Use Permits were issued by the Kansas Department of Health and Environment (KDHE) in January 2011. Once the pumping from IW40, IW43, and IW44 is considered to be optimized, groundwater samples representative of the individual wells and combined flow will be characterized with the intent of establishing design parameters for the treatment stream. Potential treated water will be discharged in accordance with the existing NPDES permit, which currently regulates treated discharge from IW41 and IW42.

Each interceptor well is controlled by a Programmable Logic Controller (PLC). The flow and water level are monitored by the PLC and can be logged by a supervisory, control and data acquisition computer (SCADA PC). Communication from the new Interceptor Wells to the SCADA PC is accomplished via radio telemetry. The new equipment has been integrated with the Wichita plant and the existing extraction and deep well disposal network.

3.2 PROCESS DESCRIPTION

New Interceptor Wells

The new Interceptor Wells were designed with a 24" diameter borehole that was advanced to a depth of approximately 85' below grade with the final depth based on local stratigraphy. The construction of the new Interceptor Wells includes 20' of 16" diameter steel-slotted well screen and approximately 65' of steel riser pipe. The riser pipe is protected by a 24" diameter well cover. The well cover is 5' long and was buried to a depth that facilitated the installation of down-well materials and aboveground piping. A schematic of the new interceptor wells is provided as Figure 5. A summary of the interceptor well system is provided as Figure 6.

The new Interceptor Wells are configured with environmental duty submersible pumps and a variable speed drive to allow adjustment of the pumping rate.

Each new Interceptor Well has its own dedicated conveyance line that runs to a Bypass Piping Manifold which can divert flow to either the deep well system or a potential future treatment system.

The anticipated flow rate for each of the new Interceptor Wells is approximately 50 gallons per minute (gpm), for an approximate combined total flow of 100 gpm. The Facility's Underground Injection Control permit allows for an average maximum daily injection limit of 1,750 gpm (averaged over 24 hours). The Facility is capable of maintaining this rate. Therefore, based on the total target flow of the existing interceptor well system (not including IW41, IW42, IW43 and IW44) of approximately 500 gpm, there is ample capacity to accommodate the combined IW43 and IW44 design flows.

New Interceptor Well Houses

The new Interceptor Well Houses are constructed of 2" tubular Aluminum on 16" centers with a .060 Aluminum skin on the exterior and interior. Instrumentation and pump controls are located in the well houses, which are adjacent to each of the new Interceptor Wells. Each well house has been installed on a concrete pad that has a flange fitting located 6" above the top of the pad, in one corner, for discharge to the Bypass Piping Manifold. Communication from the new Interceptor Well Houses to a PLC is via radio telemetry with start/stop control and monitoring data available.

3.3 EQUIPMENT AND INSTRUMENTATION

Flow Transmitters

The Flow Transmitter for IW43 is located in the Well House adjacent to IW43. The assembly consists of a transmitter and a flow cell. The Transmitter sends a signal to the PLC for monitoring and controlling the rate of groundwater recovery from IW43.

The Flow Transmitter for IW44 is located in the Well House adjacent to IW44. The assembly consists of a transmitter and a flow cell. The Transmitter sends a signal to the PLC for monitoring and controlling the rate of groundwater recovery from IW44.

Level Transmitters

Both new Interceptor wells are configured with a down-well pressure transducer that includes polyurethane- and Kevlar-lined down well cable (with a vent tube), and have a 4-20mA output with 0-30 psig range. The transducer output signal is sent to the PLC for groundwater level monitoring and pump control.

New Interceptor Well Groundwater Recovery Pumps

Both new interceptor wells (IW43 and IW44) have a Grundfos, environmental duty pump rated for 100 gpm, which is controlled by a variable speed drive.

Alarms

The control system is designed to allow the process to be operated in fail-safe mode, monitored by PLC. The major alarm condition is power disruption or failure. The alarm notification is to the operator through the PLC processor display screen. An autodialer, which is independent of the PLC, is included in the design and is available for use to allow for remote notification of alarm conditions. The control system is currently not configured to provide a response in the event that communication failure occurs between a new interceptor well and the PLC.

4.0 POTENTIAL FUTURE TREATMENT SYSTEM

The new interceptor wells will operate until flow is optimized and the groundwater system attains a steady-state condition. At that point, chemical characterization representative of the combined flow will be undertaken to evaluate treatment options. It is noted; however, that the initial characterization of groundwater for treatment purposes has been done in the past. Specifically, groundwater samples collected from monitoring wells MW140S2/S3, MW22S2, and interceptor well IW40 were analyzed for treatment system design parameters during the second semi-annual monitoring event of 2010 (CRA, February 2011) consisting of:

Iron (total and dissolved)
Magnesium (total and dissolved)
Manganese (total and dissolved)
Total suspended solids.

In addition to the parameters noted above, all wells (including MW140S2/S3) were sampled and analyzed for:

Alkalinity (bicarbonate, carbonate and total)
Calcium
Potassium
Magnesium
Sodium
Sulfate
Total dissolved solids

during the second semi-annual monitoring event of 2010 (CRA, February 2011).

The initial (preliminary) consideration of the groundwater treatment system was based on the groundwater concentrations from a sampling event that took place on November 9, 2010. Listed below are the results of that event:

Contaminant	*Influent (ppb)*
benzene	50
tetrachloroethylene (PERC, PCE)	10
TPH (as benzene)	50
methylene chloride	10
1,1,1-trichloroethane	10
1,2-dichloroethane	10

Contaminant	*Influent (ppb)*
1,2-dichloropropane	10
carbon tetrachloride	1910
chloroethane	10
chloroform (trichloromethane)	32
hexachlorobutadiene	0.02
hexachloroethane	0.05

On the basis of currently available information, the possible options for the new treatment system may include, but are not limited to, the following:

- **Deep well injection**
  - Total flow from IW43, IW44 and IW40 (no new treatment)
  - Flow from IW43 only (IW44 and IW40 to new treatment system)
- **Liquid phase carbon treatment**
  - Total flow from IW43, IW44 and IW40 (with option for chloride treatment)
  - Flow from IW44 and IW40 (no chloride treatment) (IW43 to deep well injection)
- **Air stripper, liquid phase carbon and vapor phase carbon treatment**
  - Total flow from IW43, IW44 and IW40 (with option for chloride treatment)
  - Flow from IW44 and IW40 (no chloride treatment) (IW43 to deep well injection)

Further details on the proposed treatment system will be provided to U.S. EPA following characterization of groundwater samples representative of the combined flow to the system.

5.0 ICM MODIFICATION SCHEDULE

A tentative schedule for completion of the anticipated groundwater ICM modification is provided as follows:

	Activity	*Tentative Completion Date*
i)	Well Installation	April 30, 2011
ii)	Hydraulic System Evaluation (IW40, IW41[1], IW42[2], IW43 and IW44)	June 30, 2011
iii)	Treatment System Design	December 31, 2011
iv)	Treatment System Construction	June 30, 2012

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[1] The planned hydraulic evaluation will assess removing IW41 and IW42 from service and utilizing serviceable equipment in the proposed treatment system.

[2] The planned hydraulic evaluation will assess removing IW41 and IW42 from service and utilizing serviceable equipment in the proposed treatment system.

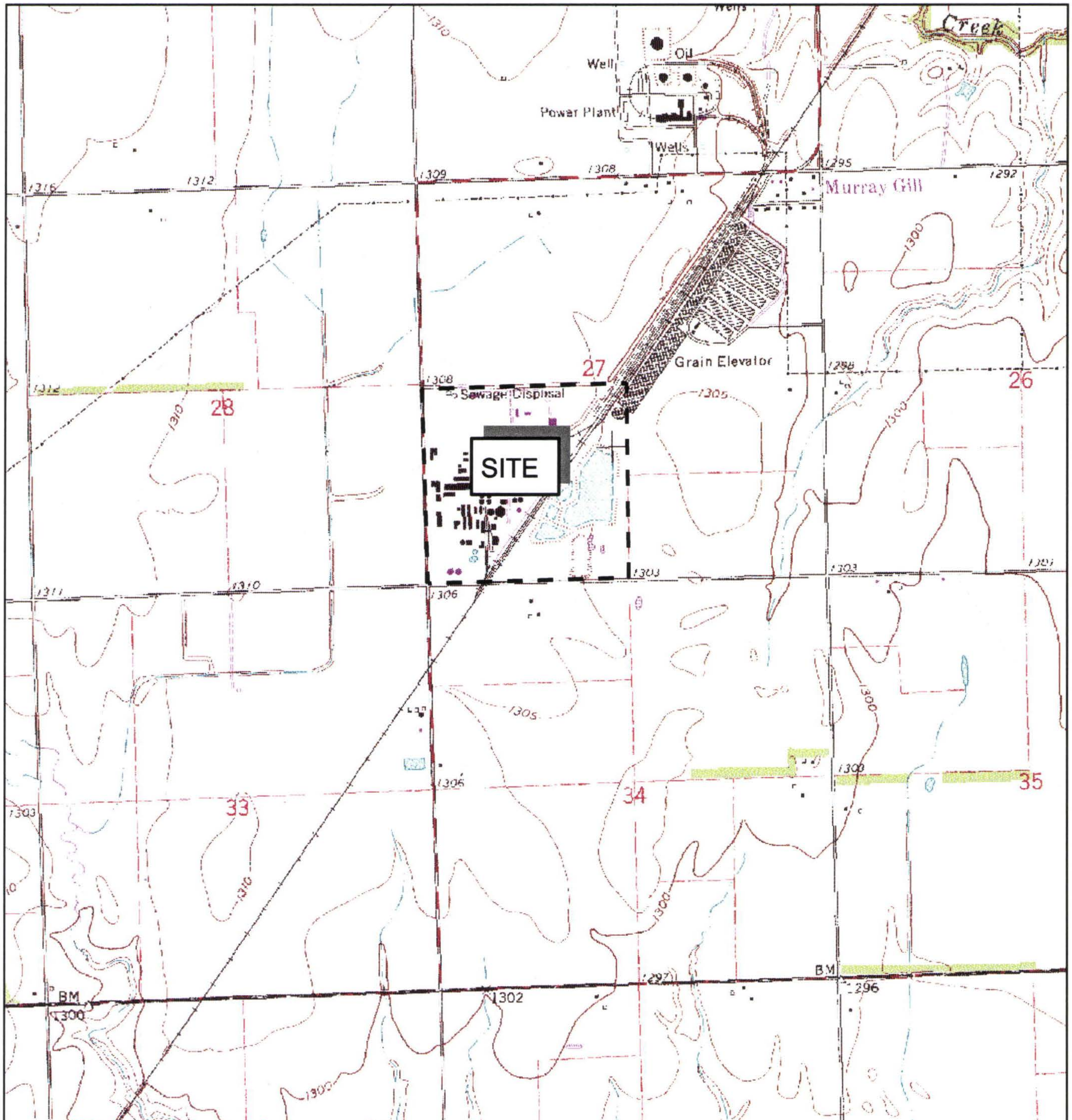
6.0 REFERENCES

Conestoga-Rovers & Associates, *Interceptor Well System Interim Corrective Measure Effectiveness Evaluation*, February 11, 2010

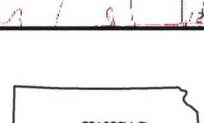
Conestoga-Rovers & Associates, *Inorganics Area, RCRA Facility Investigation (RFI)*, February 16, 2011

Conestoga-Rovers & Associates, *Second Semi-Annual Groundwater Monitoring Report, November 2010*, February 23, 2011

United States Environmental Protection Agency, *Hazardous and Solid Waste Amendments Permit, Occidental Chemicals Corporation, Inc., Wichita, Kansas, EPA I.D. KSD 007482029*, Effective date: August 30, 2007



BASE SOURCE: USGS 7.5 MINUTE TOPOGRAPHIC QUADRANGLE; BAYNEVILLE, KANSAS 1961 PHOTO REVISED 1970 & 1981



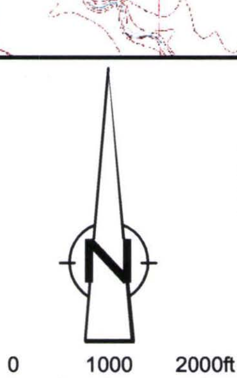


figure 1

SITE LOCATION MAP
CONCEPTUAL DESIGN SUMMARY
GROUNDWATER ICM MODIFICATION
CONCEPTUAL DESIGN SUMMARY
Wichita, Kansas

54046-D22102(022)GN-CO001 AUG 26/2011

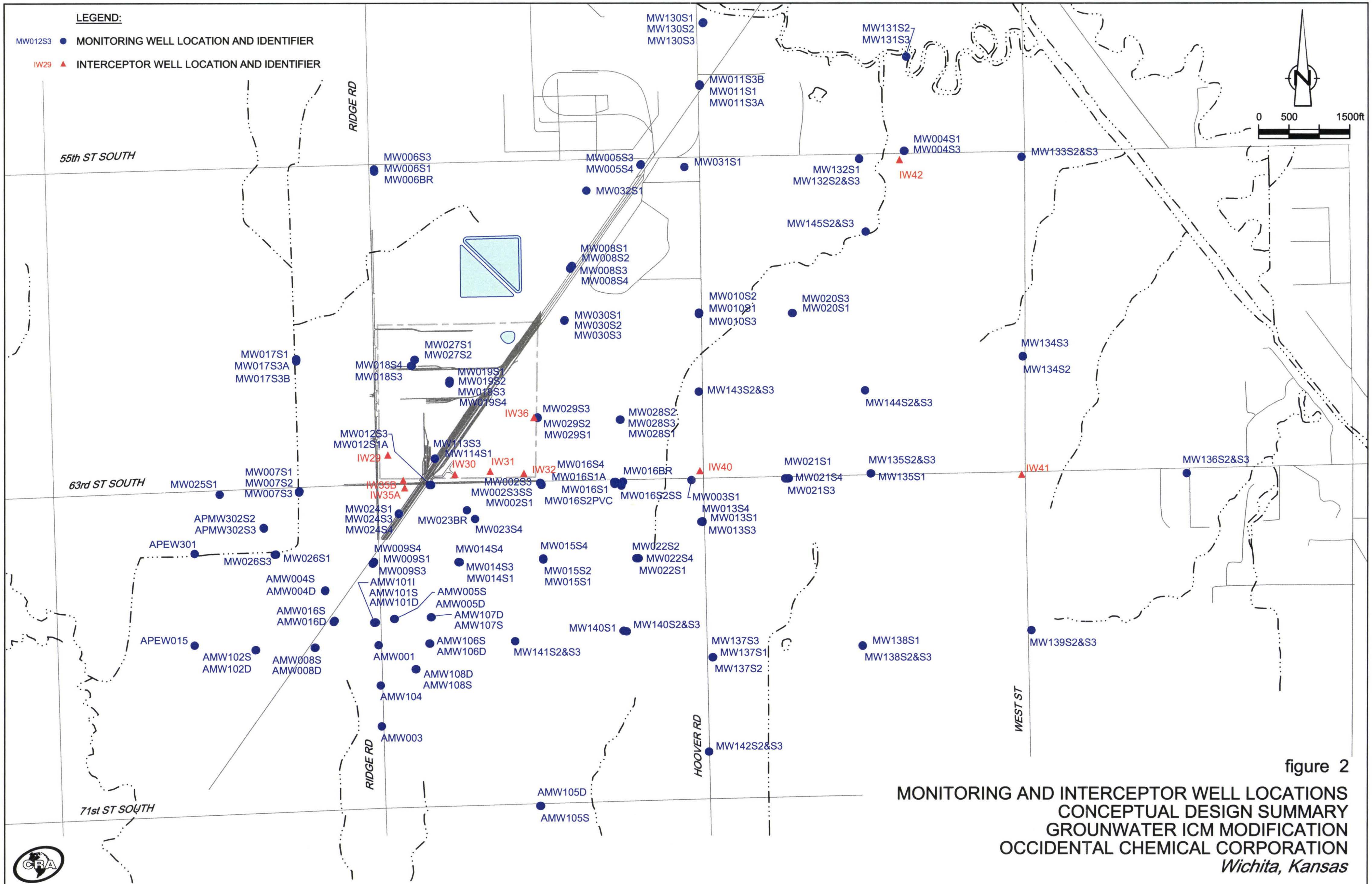
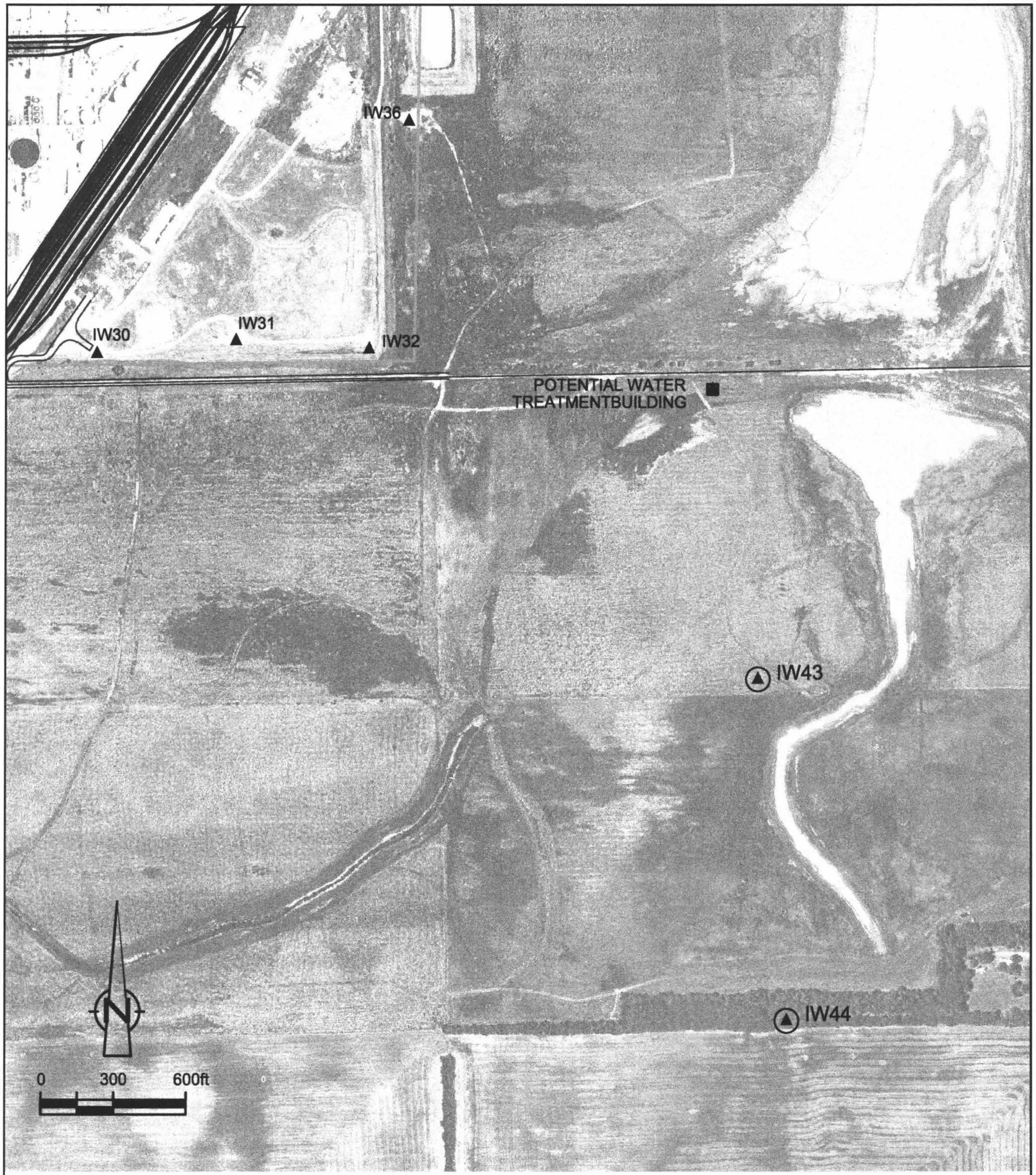


figure 2

MONITORING AND INTERCEPTOR WELL LOCATIONS
CONCEPTUAL DESIGN SUMMARY
GROUNWATER ICM MODIFICATION
OCCIDENTAL CHEMICAL CORPORATION
Wichita, Kansas

54046-D22102(022)GN-CO005 AUG 26/2011



LEGEND:

IW30 ▲ INTERCEPTOR WELL LOCATION AND IDENTIFIER

IW43 Ⓐ PROPOSED INTERCEPTOR WELL LOCATION AND IDENTIFIER

figure 3

IW43 AND IW44 PLOT PLAN
CONCEPTUAL DESIGN SUMMARY
GROUNWATER ICM MODIFICATION
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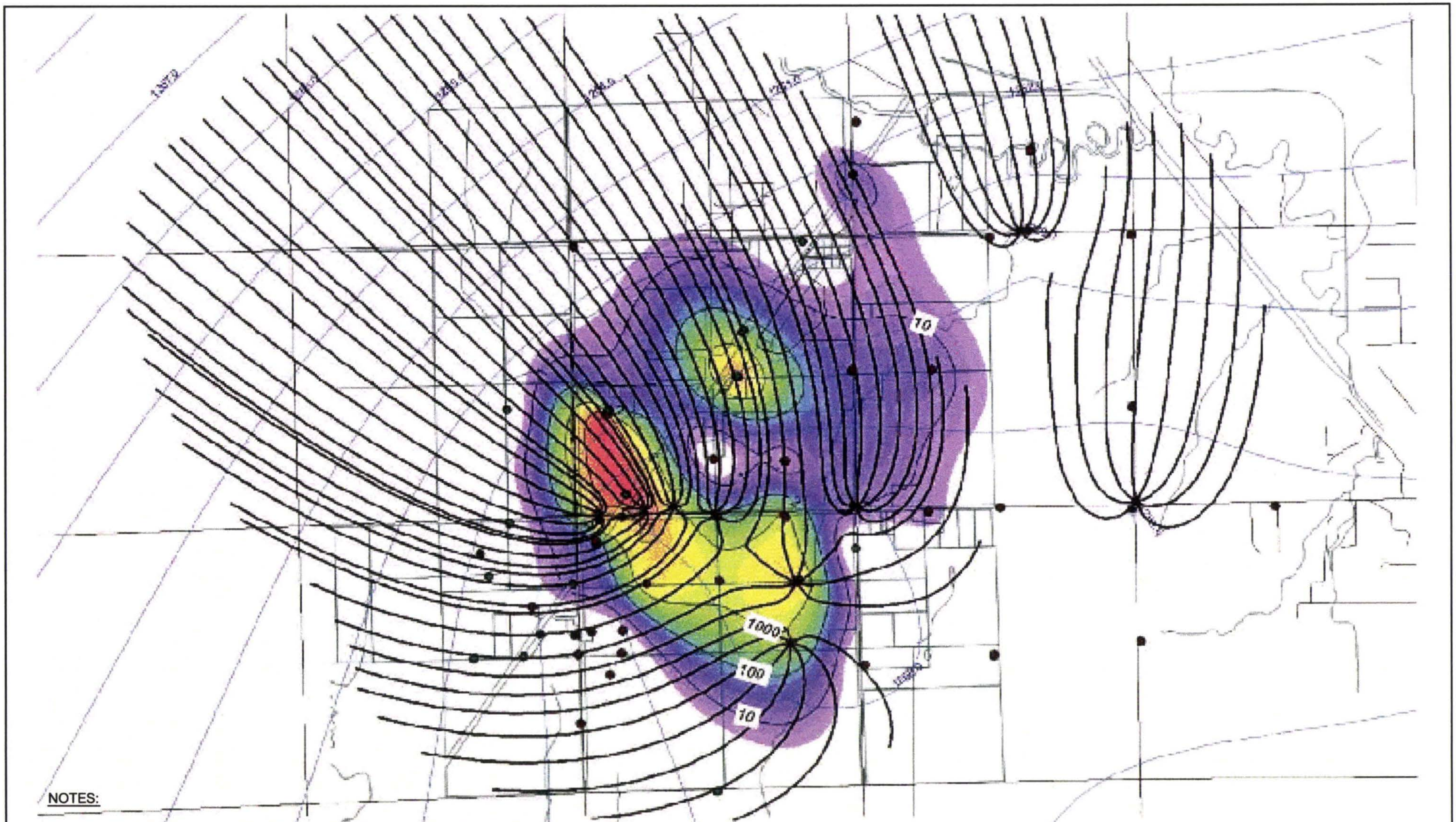
Wichita, Kansas

54046-D22102(022)GN-CO003 AUG 26/2011



NOTES:

I CONTOURS GENERATED BY GFLOW MODEL UTILIZING 2009 S2/S3 CONDITIONS.
II FLOW PATHLINES ARE 40 YEARS LONG.
III COLORED PLUME IS CARBON TETRACHLORIDE GREATER THAN 5 µg/L (MCL)
CONTOUR LABELS ARE IN µg/L
IV TOTAL PUMPING SUMMARY:
ON-SITE=200 gpm
OFF-SITE: IW40= 40 gpm; IW41 & IW42=52 gpm; IW43 & IW44=50 gpm

figure 4

SIMULATED 2010 S2/S3 AQUIFER CARBON TETRACHLORIDE PLUME
CONCEPTUAL DESIGN GROUNDWATER ICM MODIFICATIONS
OCCIDENTAL CHEMICAL CORPORATION
Wichita, Kansas

54046-D22102(022)GN-CO006 AUG 26/2011

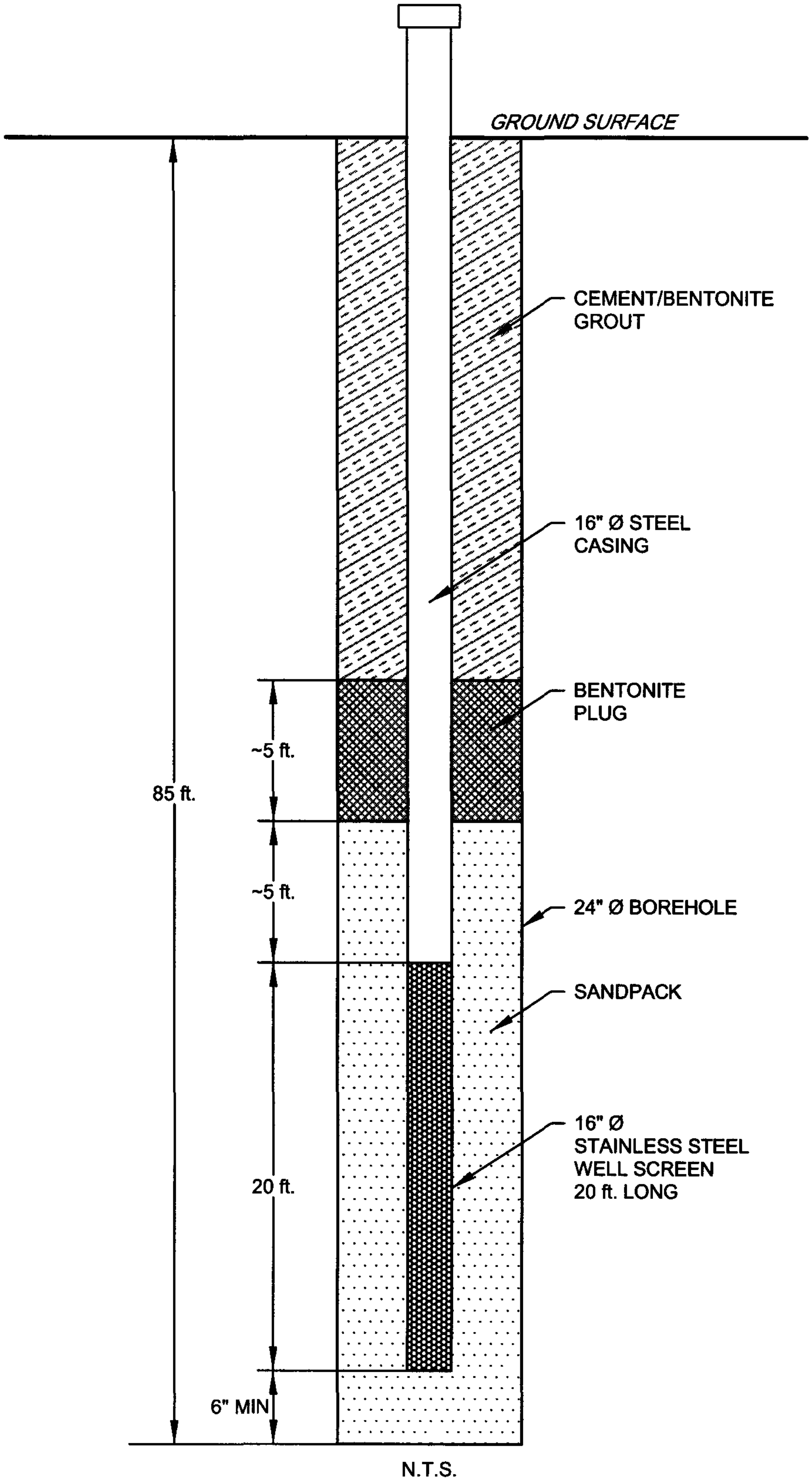


figure 5

WELL CONSTRUCTION
IW43 AND IW44 EXTRACTION WELLS
CONCEPTUAL DESIGN SUMMARY
GROUNDWATER ICM MODIFICATION
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Wichita, Kansas

CRA

54046-D22102(022)GN-CO002 AUG 26/2011

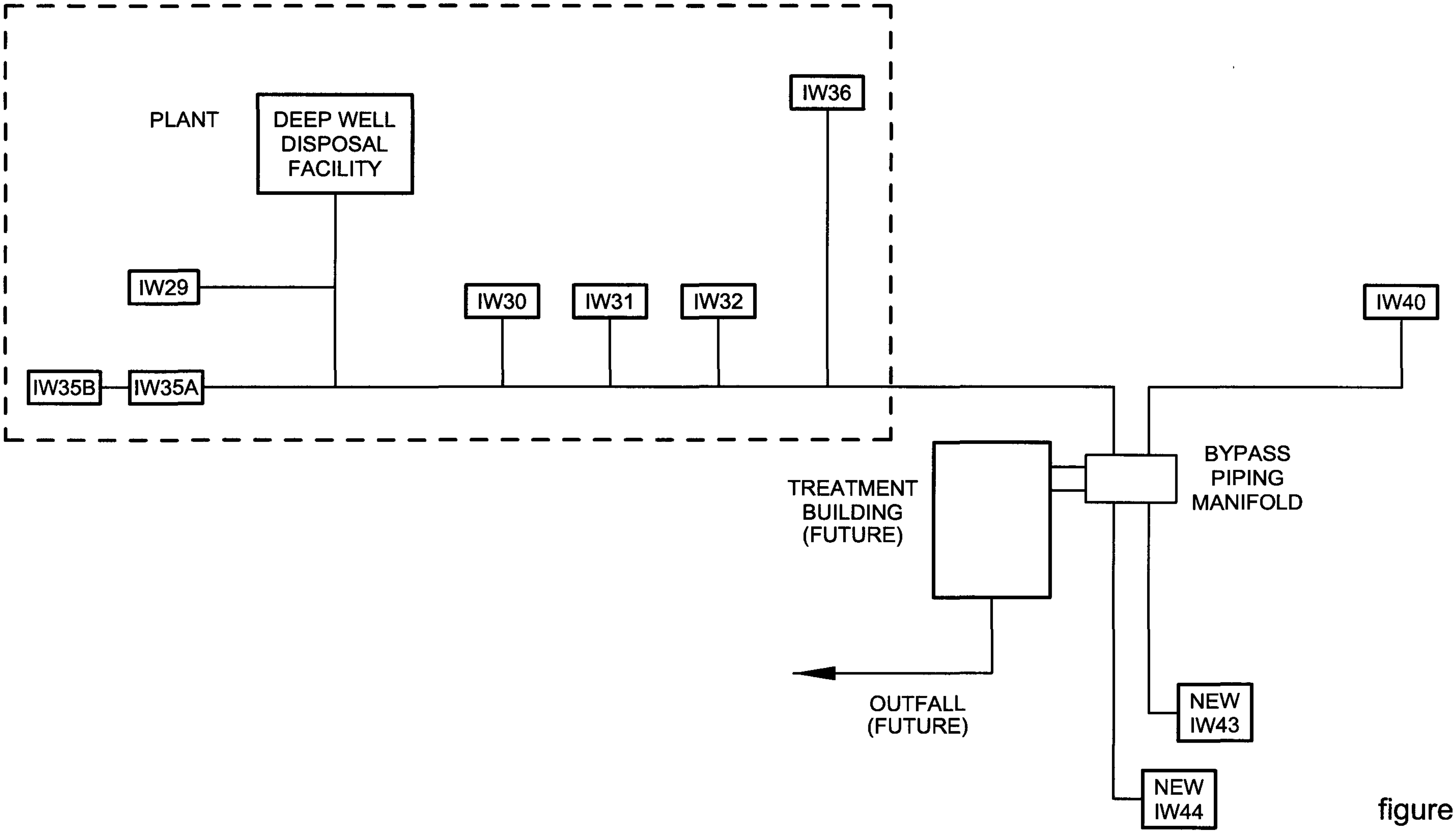

figure 6

INTERCEPTOR WELL SYSTEM
CONCEPTUAL DESIGN SUMMARY
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